

A faint, stylized lightning bolt graphic is visible in the background, extending from the top right towards the bottom left.

Assessing Global Change Impact on the US using National Lightning Data

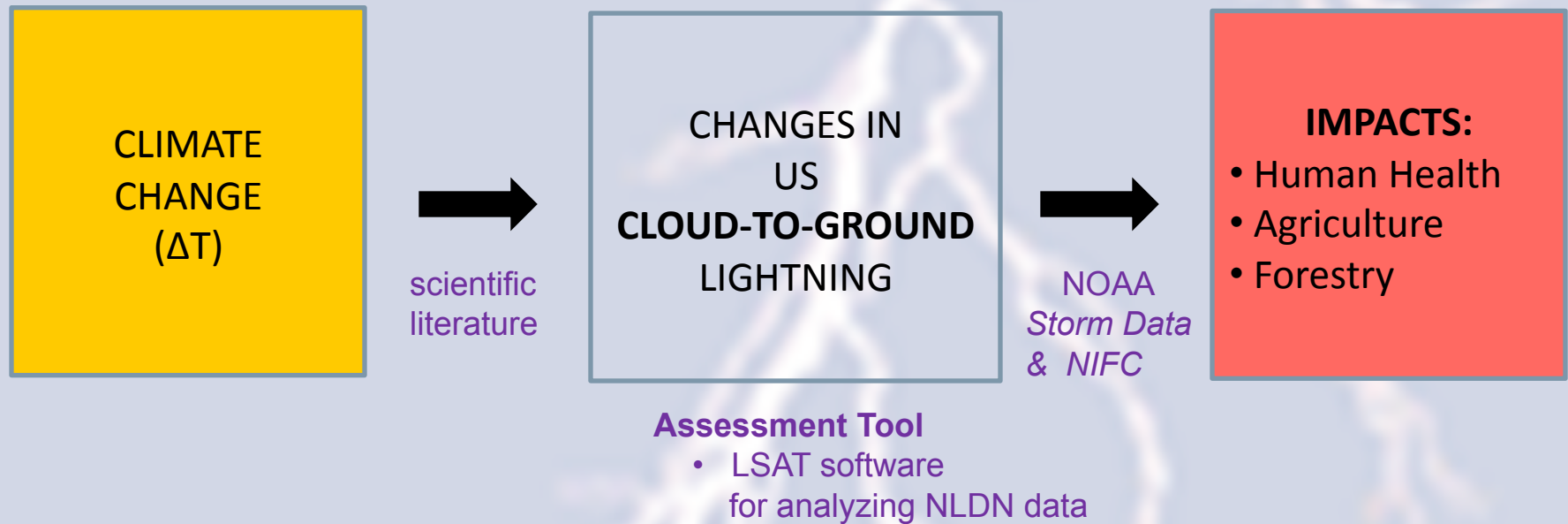
Project Status

National Climate Assessment

November 20, 2012

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Earth Science Office, NASA Marshall Space Flight Center, Huntsville, AL, USA

Project Focus



Interconnections:

IMPACTS

COSTS

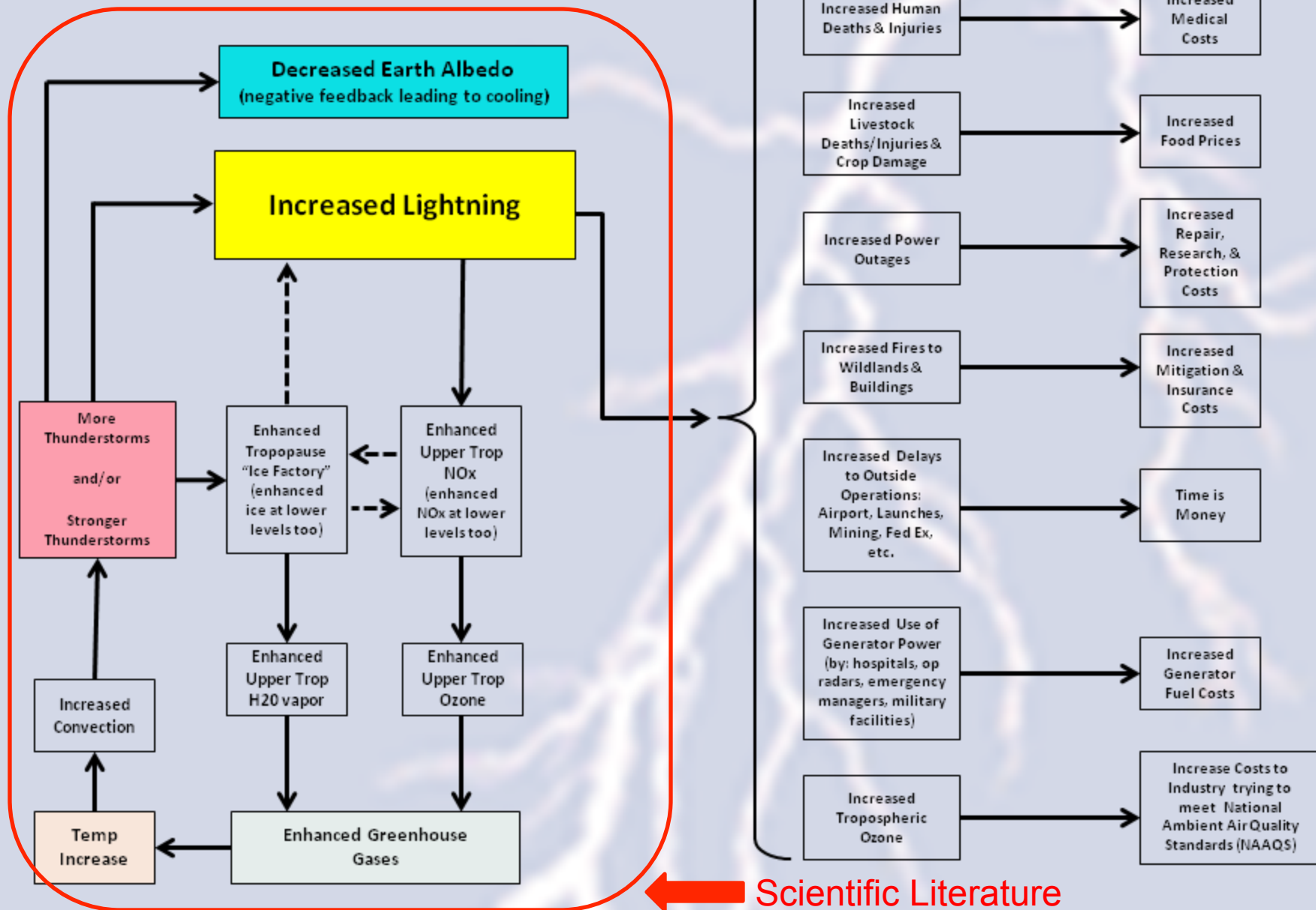


Figure 1. Overview of linkages between global climate change, lightning, and subsequent impacts/costs.

Impacts



Lightning Crop Damage
(extension.umass.edu)

Agriculture



Lightning strikes fence and kills cows lined-up near it. Photo courtesy of Ruth Lyon-Bateman.



(scienceblogs.com)

Forestry



Lightning-Caused Wildfire in Northern San Diego County.
AP photo (davisenterprise.com)

Human Health

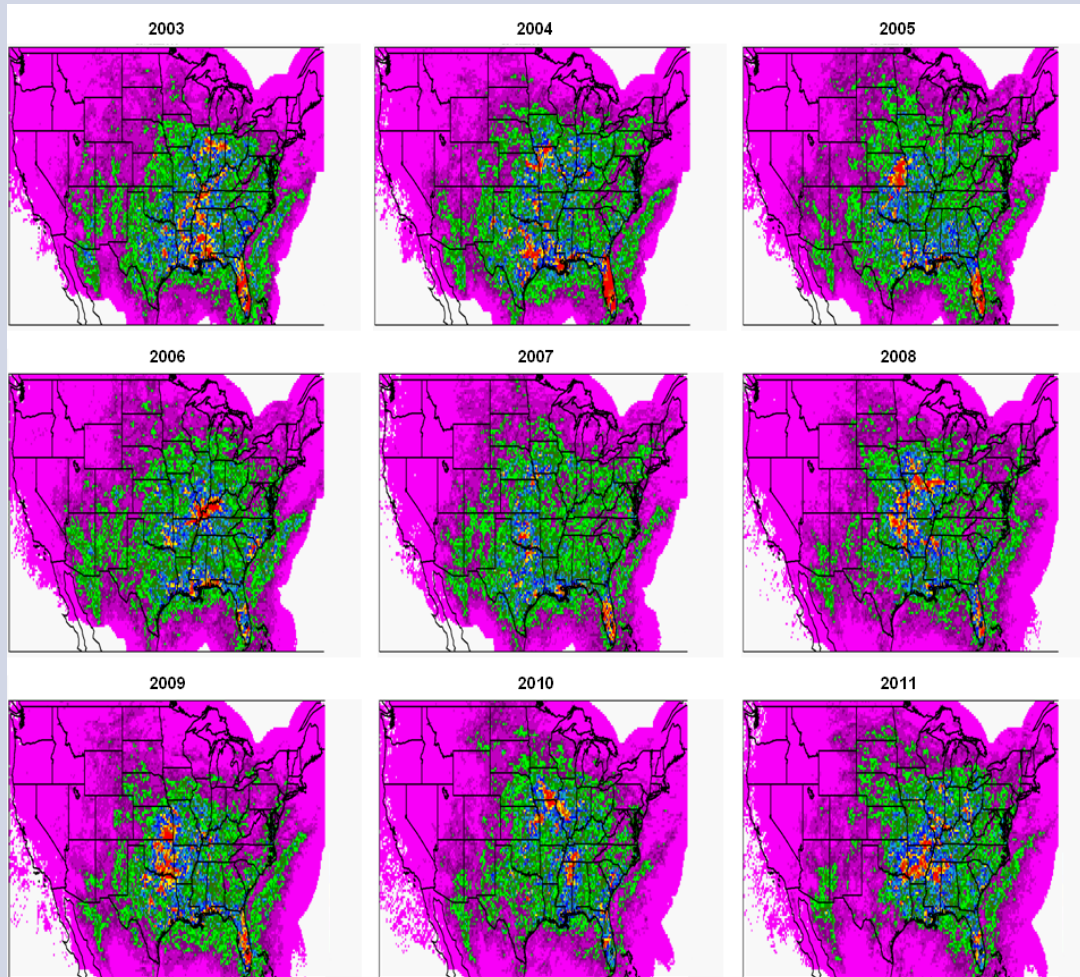


(enhs.umn.edu)

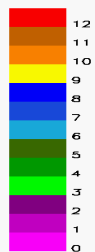
Accomplishments

- ❑ **Developed a Lightning Software Analysis Tool (LSAT)**
 - written in IDL programming language
 - ingests, calculates, and visualizes national CG lightning data
 - now serves as a new “sustaining assessment” tool
- ❑ **Applied LSAT to analyze CG lightning over a region slightly larger than CONUS during the period 2003-2011.**
- ❑ **Used NOAA *Storm Data*, and National Interagency Fire Center (NIFC) data to obtain lightning-caused death/injury, crop damage, wildfire stats.**
- ❑ **Compared average values (2003-2006) with average values (2007-2010):**
 - ✓ CG lightning frequency dropped by 10.7%
 - ✓ Fatalities dropped by 13.5%
 - ✓ Injuries dropped by 31.2%
 - ✓ Crop damage dropped by 61.25%
 - ✓ # wildfires dropped by 23.6%
 - ✓ Wildfire burn acreage dropped by 8.3%
 - ✓ Multiplicity dropped by 2.4%
 - ✓ *Peak current increased by 9.9%*
- ❑ ***Number of +CG (and +CG fraction) monotonically trended upward in 2003-2011***

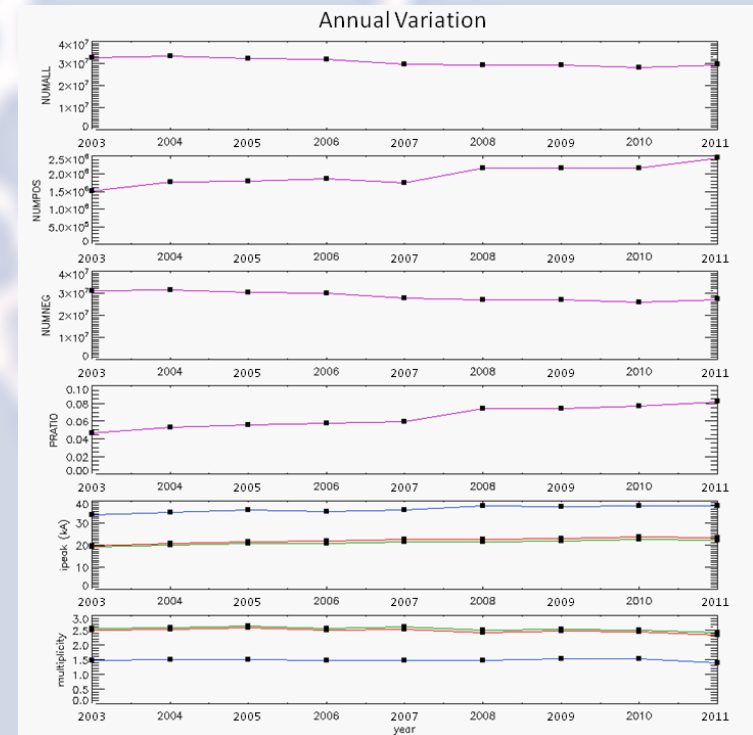
Sample of LSAT output



KEY:

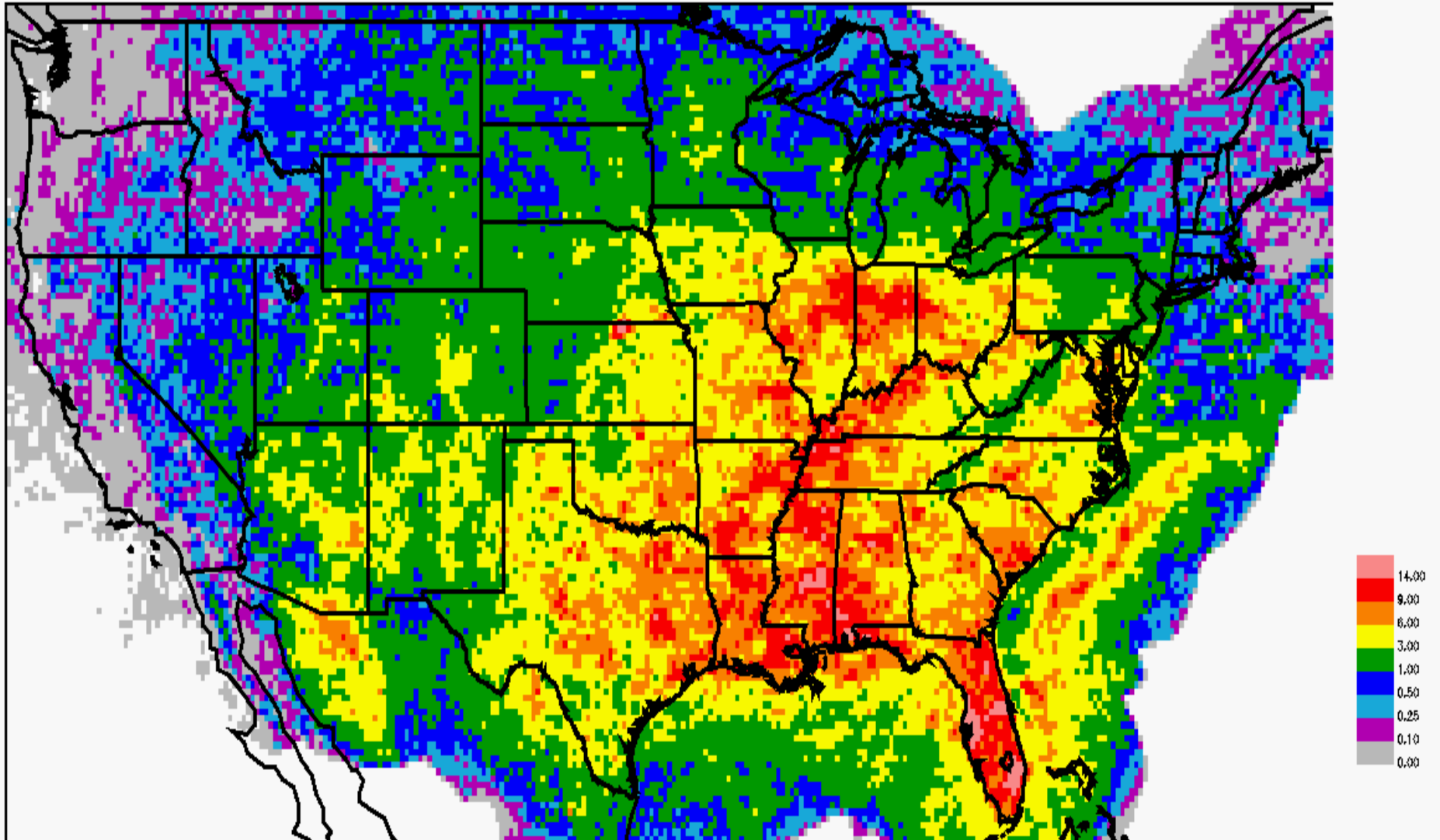


CG Flash Density
([# CGs]/km²)

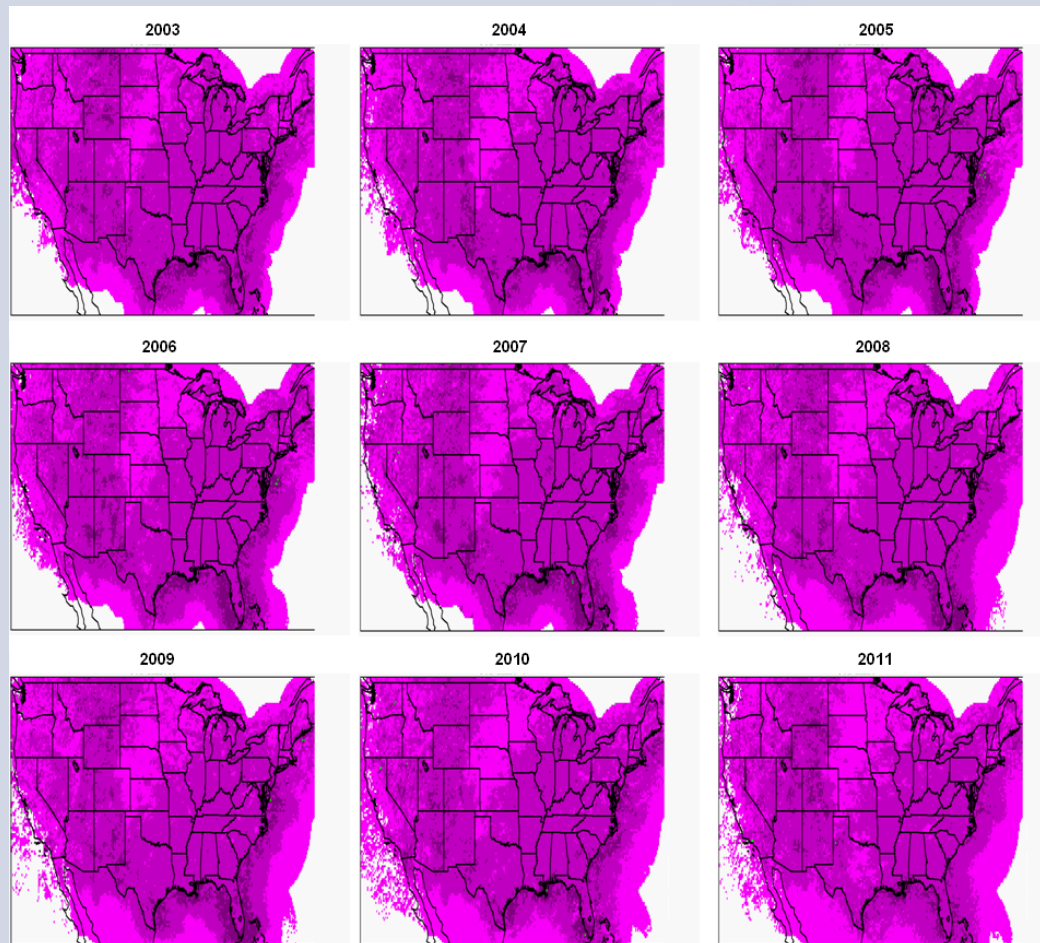


Flash Density (#/km2)

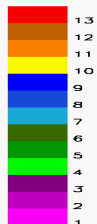
FLDALL_2003



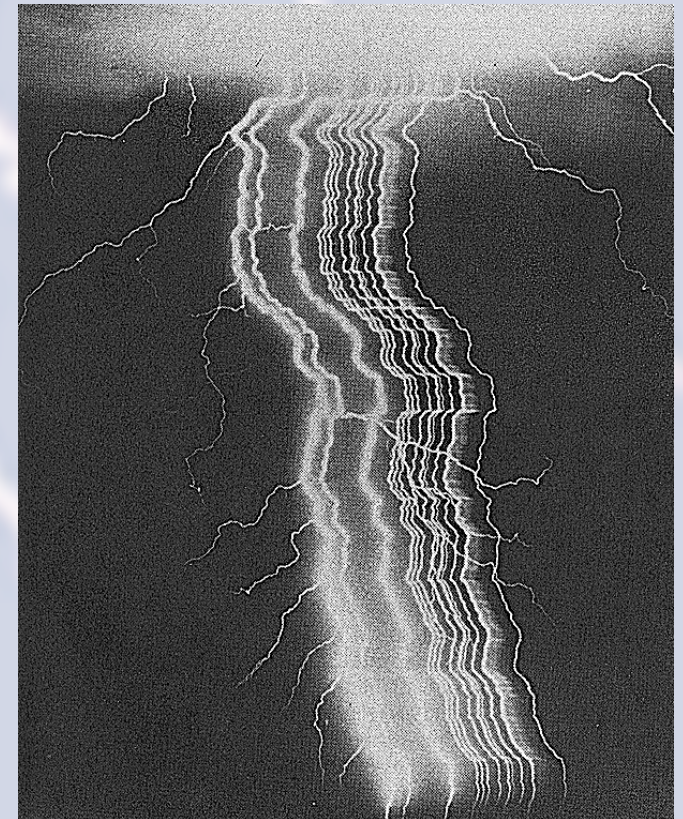
Stable Multiplicity



KEY:



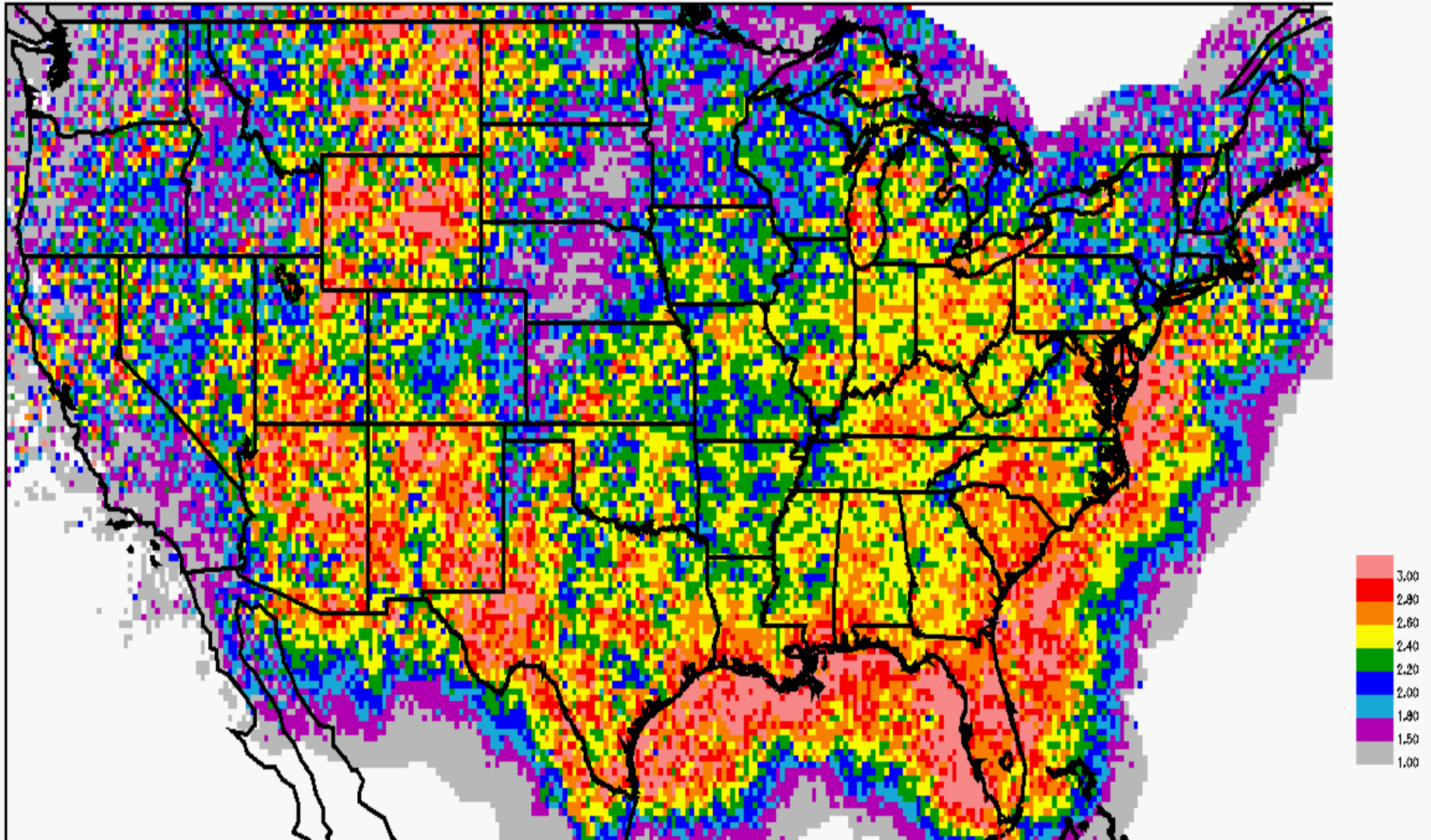
CG Multiplicity
(#)



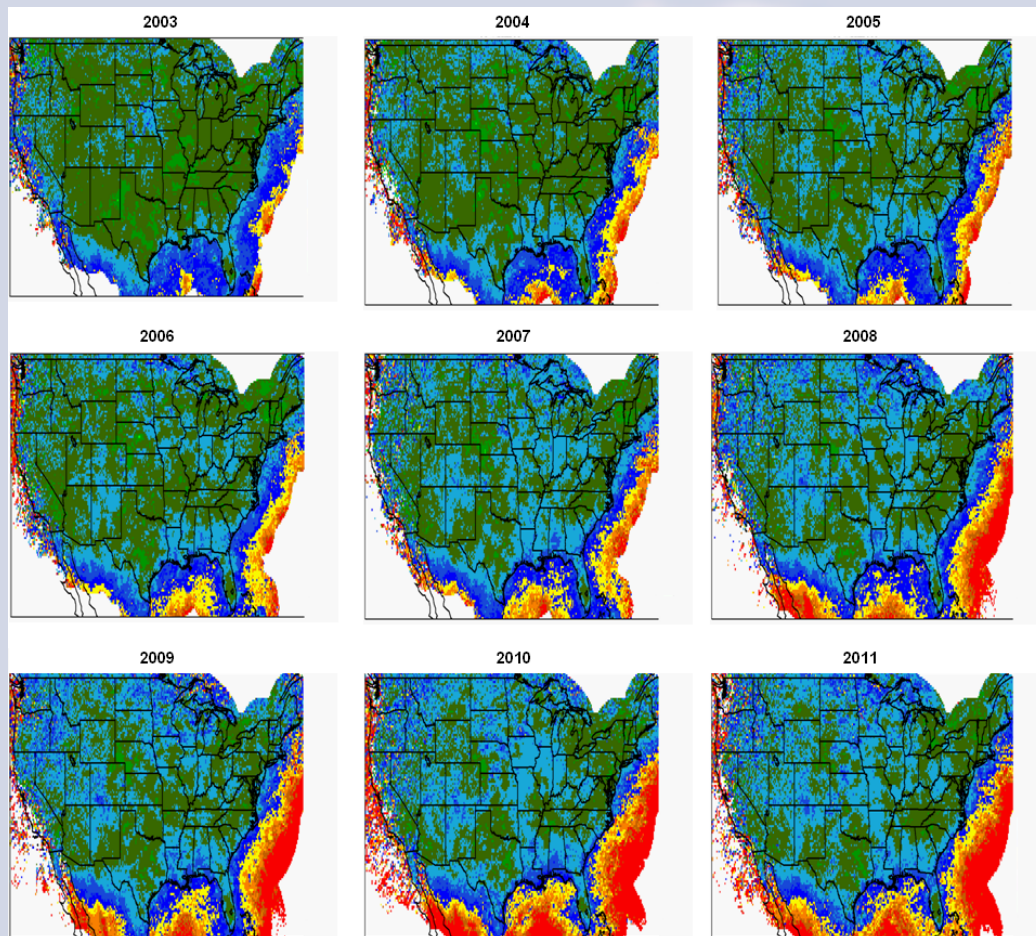
Streak photograph of lightning near Socorro, New Mexico. Courtesy, Marx Brook, New Mexico Institute of Mining and Technology.

Multiplicity

MULALL_2003



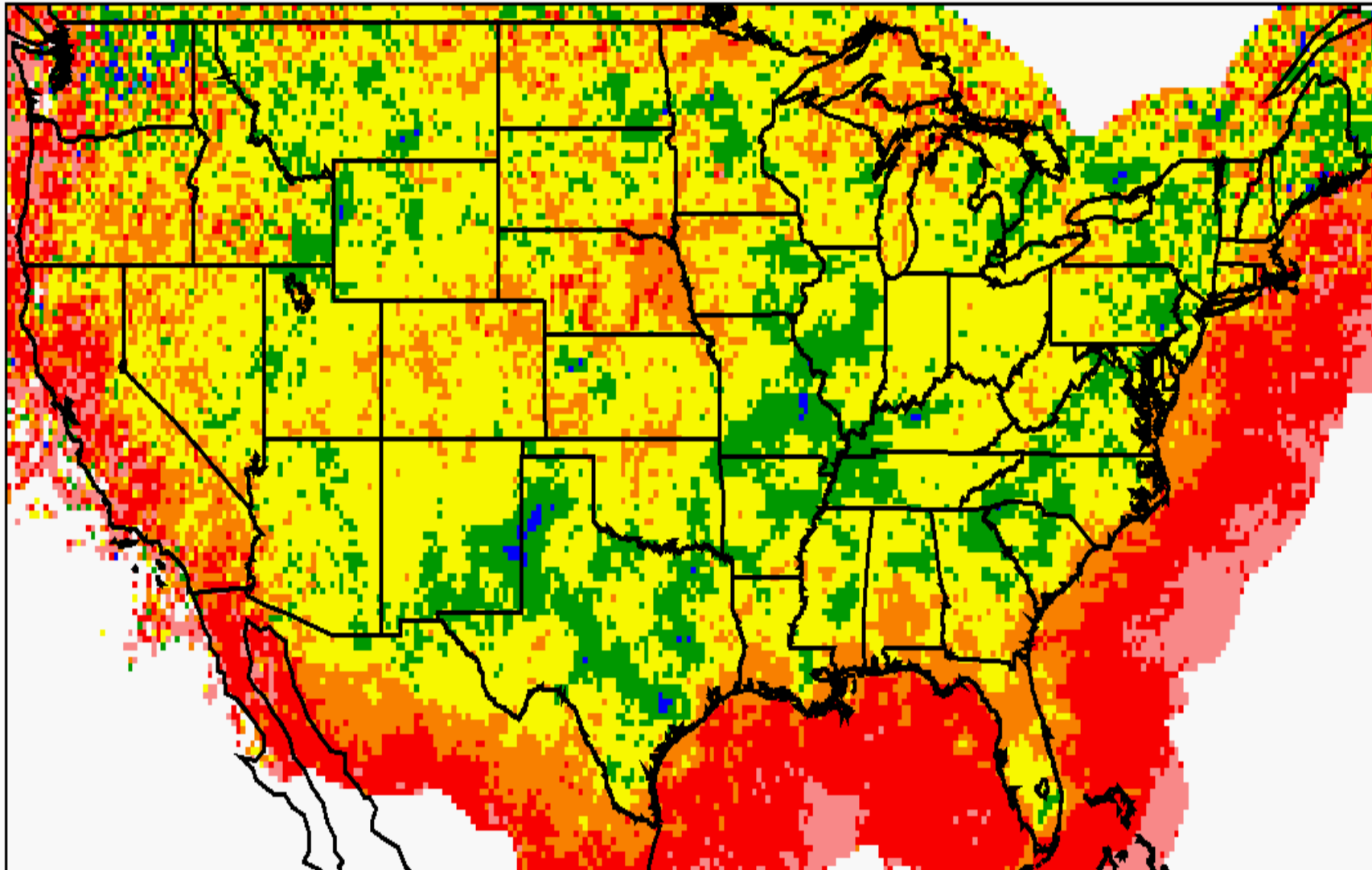
Peak Current Trends Up



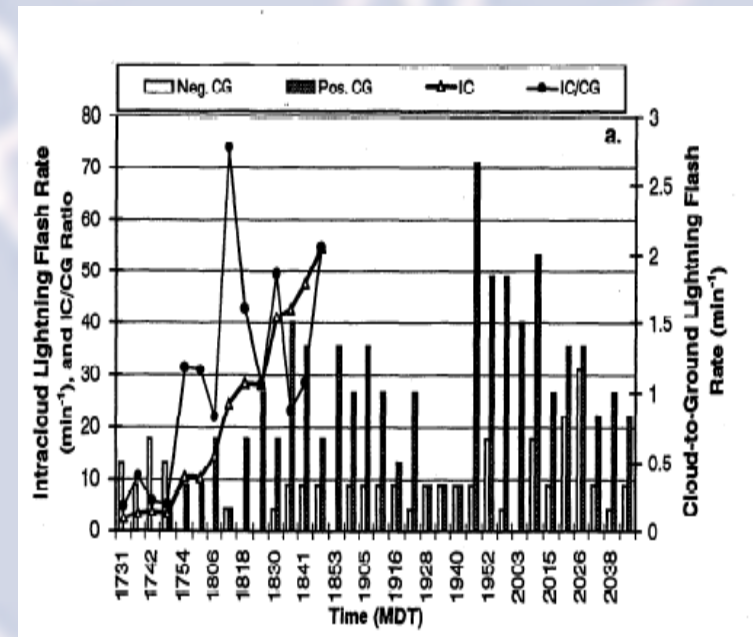
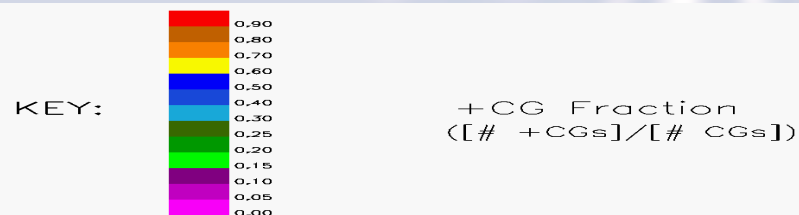
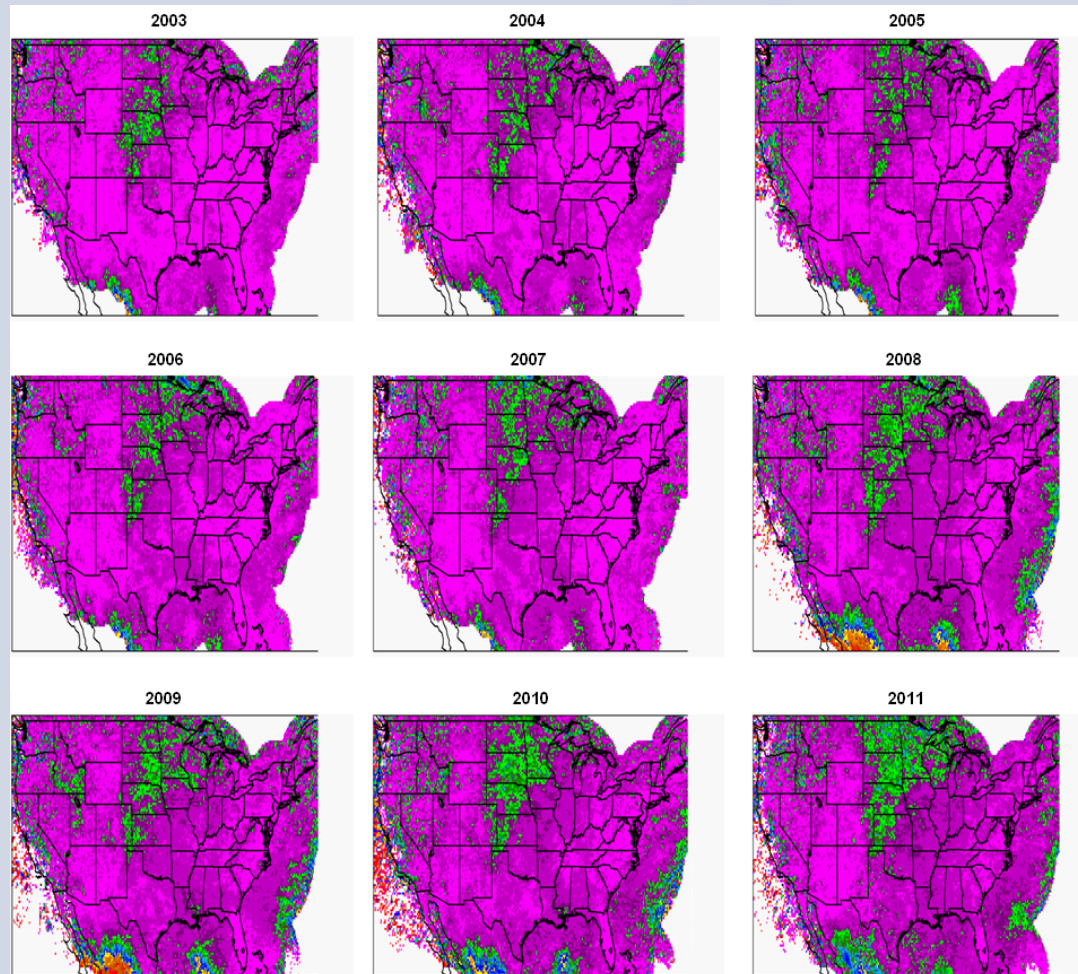
Increases in current increase the probability of igniting the object (photo from sciencefacts.us).

PEAK CURRENT (kA)

CURALL_2003



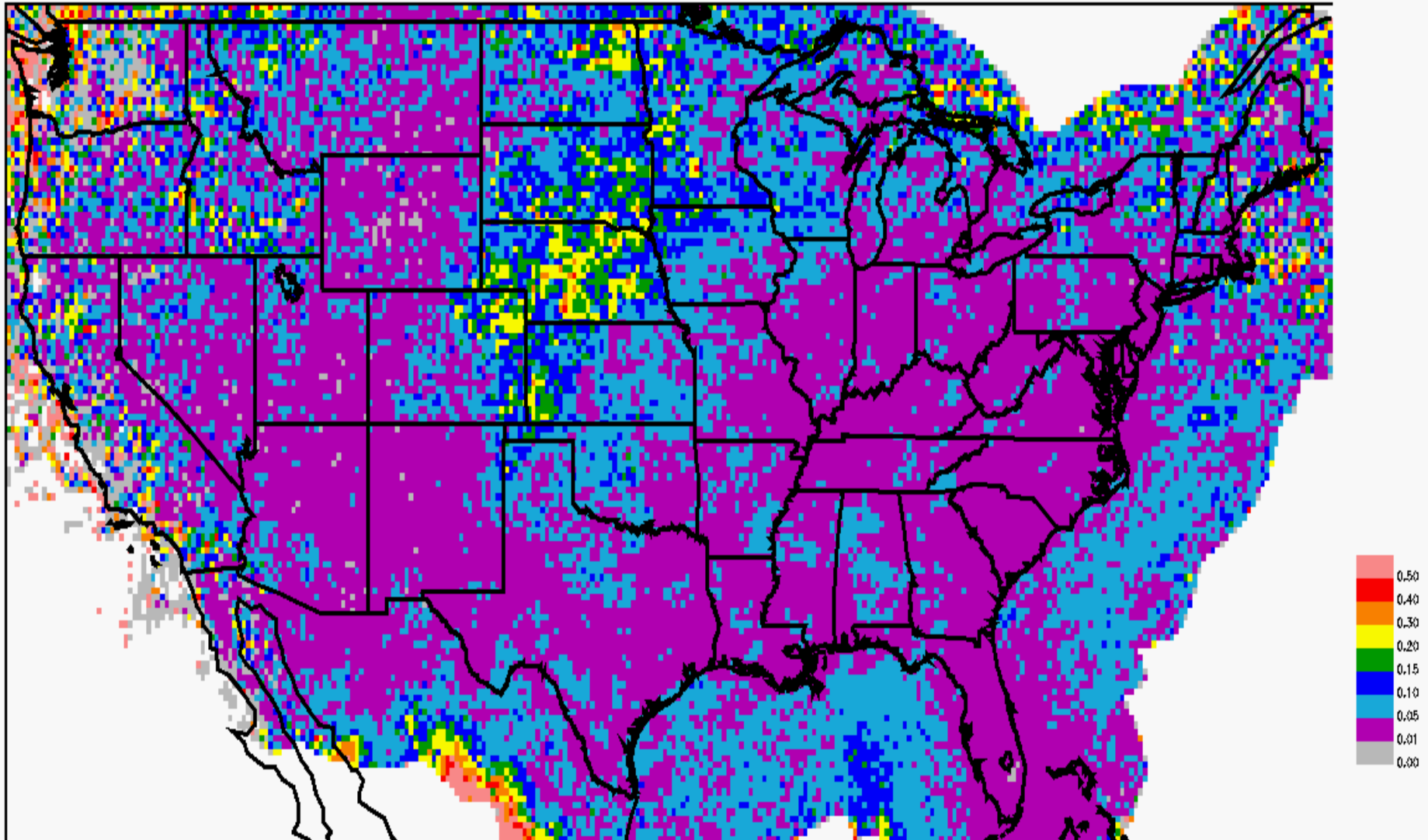
Positive CG Fraction Trends Up (linked to Severe Wx)



Carey & Rutledge (1998) show high % +CGs in severe thunderstorms.

POSITIVE CG FRACTION

PRATIO_2003



Accomplishments (cont.)

❑ Examined effects of National Lightning Detection Network Upgrades

- 2002-2003 Upgrade (all sensors replaced w/new IMPACT-ESPs + 8 sensors added)
- 2004 Propagation Model Upgrade (increases peak current values)
- 2006 Sensor Addition Upgrade (2 sensors added SE of Florida)
- 2006 E-Field Waveform Detection Criteria Upgrade (short PTZ waveforms admitted to allow limited IC detection; increases CG count but some are cloud flashes)
- 2006 15kA Rule Upgrade (no effect since already accounted for)
- 2008 Location Algorithm Upgrade (extend range to offshore & N. Mexico)
- 2008 Duplicate/Misplaced Events Upgrade (improvements in removing these)

❑ **Only important effect seems to be a network change in 2008 that abruptly increased +CG fraction. Still investigating.**

Accomplishments (cont.)

❑ Completed conservative risk-based assessment

$$\underbrace{\left(\frac{\Delta \text{Impact}}{\Delta \text{Lightning}} \right)}_{\text{From LSAT}} \underbrace{\left(\frac{\Delta \text{Lightning}}{^{\circ}C} \right)}_{\text{From Literature}^*} = \underbrace{\left(\frac{\Delta \text{Impact}}{^{\circ}C} \right)}_{\text{Result}}$$

Human Health:

Fatalities:

13.98 deaths per 1°C

Injuries:

87.47 injuries per 1°C

Agriculture:

Crop Damage:

\$49,348 per 1°C

Forestry:

Wildland Fires (Number):

4091.0 wildfires per 1°C

Wildland Fires (Acres):

936,097.6 acres per 1°C

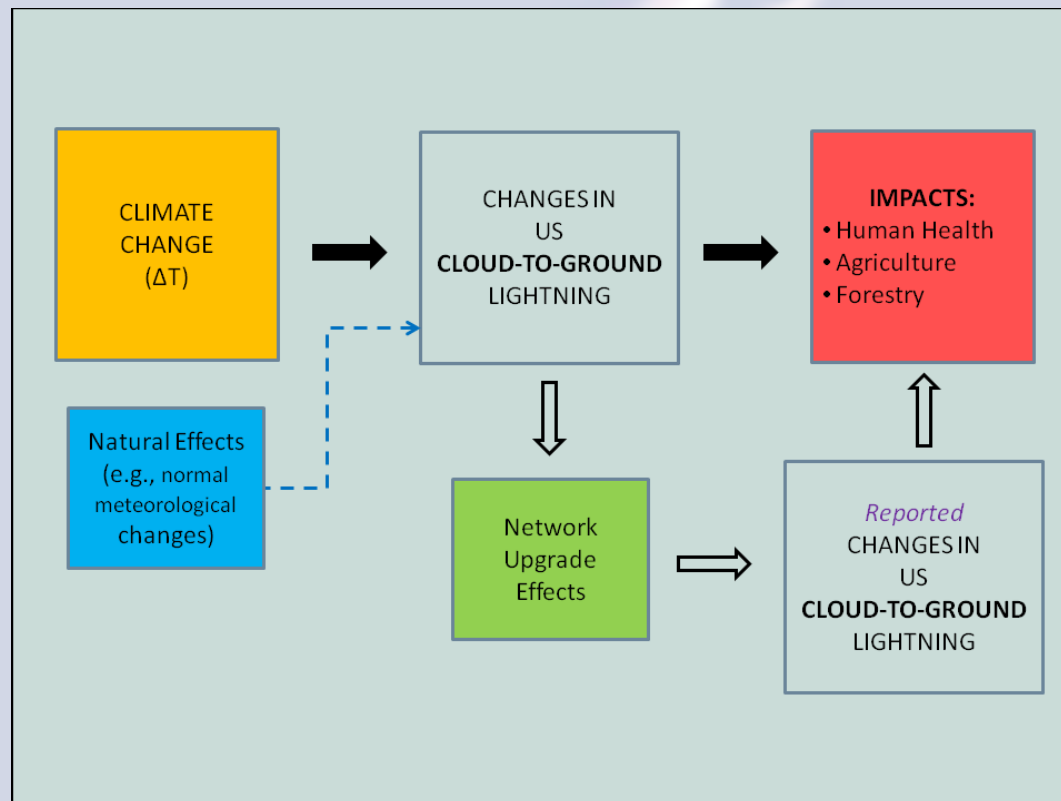
❑ Completed a 32 page Technical Input Report (TIR) to summarize findings.

❑ Submitted TIR on February 22, 2012. Peer-Reviewed & Revised by May 3.

*Reeve & Toumi (1999): 40±14% change in CG frequency per 1°C; and Price & Rind (1994) found that CG frequency more sensitive to temperature changes than cloud flash frequency.

Plans for Future

- ❑ Apply LSAT to complete 2012 analyses.
- ❑ Convert TIR into journal article for publication
 - Add 2012 results
 - Continue Examining Effects of Network Upgrades on Lightning
 - Examine Natural Effects on Lightning (other than Climate Change):



Plans for Future (cont.)

❑ Thru ROSES A.47 Call, develop & track additional indicators:

➤ TRMM/LIS data to examine lightning NO_x in Southern CONUS:

- Total (CG + cloud flash) lightning
- Flash optical area
- Flash optical radiance

Increases in these increase NO_x & therefore influence Ozone and OH radical concentrations (hence climate).

➤ Collaborate with City College of New York & NOAA/CREST to develop & track additional indicators that use CONUS radar data:

- (Lightning/Rain) Ratio: Important for “dry lightning” (Wildfires)
- (Lightning x Rain) Product: Characterize freq of intense convective events (related to Extreme Wx).

The background of the slide is a solid light blue color. Overlaid on this background is a large, stylized white lightning bolt that branches out in several directions, creating a dynamic and energetic visual effect.

Thank You